THE INTERNATIONAL MAGAZINE OF METHODS FOR ENGINEERING/OPERATING PEOPLE

Petroleum Engineer INTERNATIONAL

NOVEMBER 1980 • $3.00 PER COPY

20515 153150 PEI
1979 STAT REFERNCE INDEX
CONGRESSIONAL INFORMATION SVC
7101 WISCONSIN AVE DC 20014
WASHINGTON

ENHANCED RECOVERY

- Crude Response To CO_2 Slugs, p. 42
- Unconvential And Convential Gas, p. 20
- Removing Nitrogen From Natural Gas, p. 50
- New Approach To Secondary Recovery, p. 27

Mixed Emotions Greet Rig Record

Euphoria that greeted the record high rig count on September 29 was tempered somewhat by a reminder from C. John Miller, president of the Independent Petroleum Association of America, that it is not realistic to compare the number of rotary drilling rigs active today with the number active in 1955.

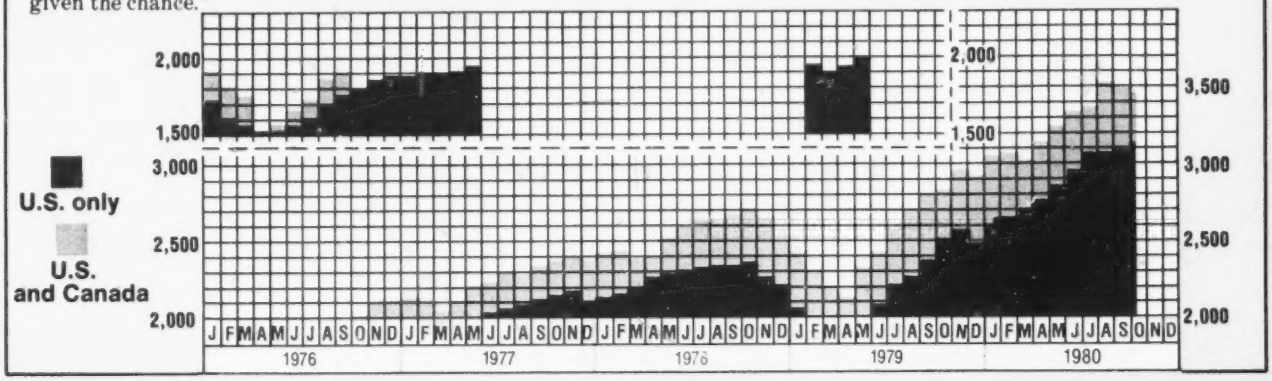
"Back then," Miller pointed out, "we (the U.S.) were consuming 8.4 million b/d. In 1979, consumption was 18.4 million b/d – a 117% increase. It is clearly not good enough in 1980 to remain satisfied with a 1955 drilling pace."

Miller did emphasize, however, that the increased activity is a very positive sign. "What these figures prove, and I hope demonstrate to this nation's leaders, is that the oil and gas industry is prepared to meet the challenges of increased production if only given the chance."

Rotary Rigs Actually Making Hole In United States & Canada

As Reported to International Association of Drilling Contractors by Hughes Tool Company

	Sept. 15, 1980	Sept. 22, 1980	Sept. 29, 1980	Oct. 6, 1980
Alabama	15	14	15	14
Alaska				
Land	10	13	12	12
Offshore	2	2	1	1
Arkansas	31	30	33	35
Arizona	1	1	0	1
California				
Land	106	110	109	100
Offshore	17	17	17	17
Total	123	127	126	117
Colorado	74	76	75	75
Florida	6	5	4	4
Idaho	1	1	1	1
Illinois	30	30	20	24
Kansas	144	145	143	142
Kentucky	1	1	1	0
North Louisiana	57	60	61	57
South Louisiana				
Inland Waters	75	80	78	79
Land	167	167	174	170
Offshore	148	146	141	143
Total	447	453	454	449
Michigan	34	32	35	35
Mississippi	54	57	54	51
Montana	55	59	58	55
Nebraska	12	15	18	18
Nevada	7	7	7	6
New Mexico	132	130	129	126
New York	7	6	6	6
North Dakota	86	84	92	87
Ohio	81	80	83	85
Oklahoma	456	440	450	452
Oregon	1	1	1	1
Pennsylvania	35	36	37	37
Rhode Island				
Offshore	2	2	2	2
South Dakota	1	1	1	1
Tennessee	1	1	1	1
Texas				
Offshore	64	64	69	72
Dist. 1	42	48	47	42
Dist. 2	52	53	54	53
Dist. 3	167	162	165	172
Dist. 4	105	100	99	103
Dist. 5 & 6	116	127	121	122
Dist. 7B	75	78	82	80
Dist. 7C	72	72	71	70
Dist. 8	113	105	109	103
Dist. 8A	69	72	77	73
Dist. 9	80	79	70	70
Dist. 10	51	59	58	55
Total	1016	1019	1022	1015
Utah	50	55	55	53
Washington State	1	1	1	1
West Virginia	38	45	46	43
Wyoming	161	155	155	165
Total U.S.	3115	3124	3138	3115
Western Canada	423	408	378	369
Eastern Canada	9	9	9	9
U.S. and Canada	3547	3541	3525	3493


2,000
1,500
3,000
2,500
2,000
U.S. only
U.S. and Canada
2,000
1,500
3,500
3,000
2,500
2,000
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1976
1977
1978
1979
1980

PETROLEUM ENGINEER INTERNATIONAL • 800 Davis Building • Dallas, Texas 75202 • **TWX** 910-861-9306

Abbott Sparks — President
John G. Grant — Publisher and Vice President
W. B. Bleakley — Editor
Richard D. McNally — Associate Editor
Mary Jane Ellis — Assistant Editor
Laura Jacobus — Assistant Editor
Edna Taylor — Editorial Assistant
J. E. (Hank) Kastrop — Consulting Editor
Renn Rothrock, Jr. — Consulting Editor
Ernestine Adams — Editor, Energy Management Rpt.
Julie Fonner — EMR Assistant Editor
Gregory Martin — Editor, Energy News/Energy Week
Sharon Hutcheson — Editorial Assistant
George O. Ives — Offshore Technology Editor

4151 Southwest Frwy., Suite 115, Houston, Tex. 77027

•

Alan Hilton — Service R&D Manager
Denise Tevis — Service R&D Department
Diane Mosman — Reader Service

•

Jane Dietz — Production Department Manager
Don Fickert — Graphics Director
Janell Fowler — Production Manager
Debbie Cooper — Production Coordinator
Bart Blankenburg — Presentation
James Duke — Presentation
Victoria Valentin — Presentation
Laura Page — Presentation

•

Gary Hogan — Business Manager
Jack Schabel — Circulation Director
Royal Courtney — Circulation Fulfillment Manager
Gary Rothell — Classified Advertising Manager

ADVERTISING SALES OFFICES

EASTERN: Richard Martin, P.O. Box 89, Tennent, New Jersey 07763, (201) 446-3230
CHICAGO 60646: Bill Facinelli, Dwain Holmgren 4761 West Touhy Ave., Lincolnwood, Illinois, (312) 679-1100
OHIO, WESTERN PA.: Dwain Holmgren, 4761 West Touhy Avenue, Lincolnwood, Illinois (312) 679-1100
LOS ANGELES 91106: Bruce Berkey, 61 S. Lake Ave., Box 4566, Pasadena, Calif., (213) 681-0685.
HOUSTON 77027: Jess Adkins, Vice Pres., Gulf Coast Regional Manager, **Barry Bikin, Hal Odum,** 4151 Southwest Freeway, Suite 115, (713) 626-7850
DALLAS 75202: Ed Sealey, 800 Davis Bldg., (214) 748-4403, TWX 910-861-9306
WEST TEXAS: Rusty Meador, P.O. Box 611, Eldorado, Texas 76936 (915) 853-2689
UNITED KINGDOM, NETHERLANDS, SCANDINAVIA: Intergroup Communications, Inc., **Wallace K. Ponder, Paul Dimmock,** 31, Lyncroft Ave., Pinner, Middlesex HA5 1JU, England, (01) 868-9289, Cable: PACOM PINNER (U.K.)
FRANCE, ITALY, BELGIUM, SWITZERLAND: Gerard Lafargues, 32, rue Desbordes Valmore, 75016-Paris, France. Telephone: 504 97 94
JAPAN: Masby Yoshikawa, Orient Echo, Inc., 11th Floor Sankyo Bldg., 7-12 Tsukiji 2-chome, Chuo-ku, Tokyo, Telephone: 541-4923, Cable: MYORIENTECHO
GERMANY, AUSTRIA: S.I.P.A.S., **Wm. J. M. Sanders, Paul J. Verbunt,** Raadhuisstraat 24, P.O. Box 25, 1484 EN Graft-de Ryp, Holland, Telephone 02997-1303 and 3660. Telex: 13039 sipas nl, Telegrams: SIPAS-Amsterdam

ENERGY PUBLICATIONS
• a Division of Harcourt Brace Jovanovich •
P.O. BOX 1589 • 800 DAVIS BUILDING
DALLAS, TEXAS 75221 • (214) 748-4403

PETROLEUM ENGINEER INTERNATIONAL
Pipeline & Gas Journal
Energy Management Report
Energy News • Energy Hedge

HBJ A HARCOURT BRACE JOVANOVICH PUBLICATION

ABP ABC

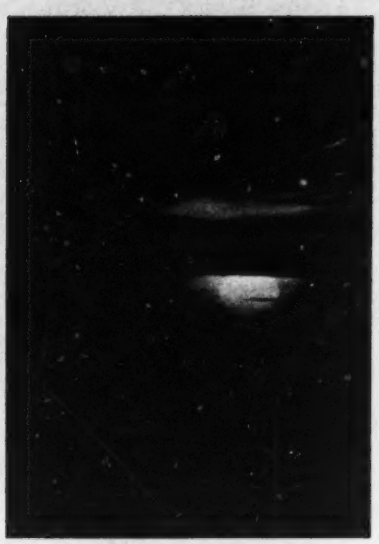
EDITORIAL ADVISORY COMMITTEE
Lloyd E. Elkins, Petroleum Consultant
Bennie L. Franks, Vice President, Production Operations, Sun Production Co.
Dennis E. O'Brien, Technology Section Head, Exxon Chemical Company
B. R. Jones, President, Eagle Production and Drilling Co.
Frank Schuh, Director of Engineering Development, ARCO Oil and Gas Co., a Division of Atlantic Richfield Co.
Marius J. Mes, Senior Research Scientist, Production Research Department, Conoco Inc.

PETROLEUM ENGINEER INTERNATIONAL (USPS 429-380) published 15 times each year, monthly plus March 15, July 15 and November 15, by Energy Publications Division, Harcourt Brace Jovanovich, P.O. Box 1589, Dallas, Texas 75221.

November, 1980, Volume 52, No. 13. Copyright© 1980 by Harcourt Brace Jovanovich, Inc. All rights reserved. No part of this publication may be transmitted or reproduced in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without permission in writing from the publisher. Subscription rate to personnel employed by companies involved with exploration, drilling, production, or field processing of oil or gas: one year $12.00, two years $18.00, three years $24.00 for North, Central, and South America. Outside North, Central, and South America: one year $25.00, two years $35.00, three years $45.00. Subscription rate for all others: $25.00 for one year. Single copy price $3.00. Entered as second class mail matter January 15, 1949, at the post office in Dallas, Texas, under the act of March 3, 1879. Microfilm copies are available through University Microfilms, Inc., 313 North First Street, Ann Arbor, Michigan. Indexed by Applied Science, Technology Index and the Engineering Index, Inc.

Postmaster: Send address changes to PETROLEUM ENGINEER INTERNATIONAL, P.O. Box 1589, Dallas, Texas 75221, USA.

HARCOURT BRACE JOVANOVICH PUBLICATIONS
ROBERT L. EDGELL, Chairman; RICHARD MOELLER, President; LARS FLADMARK, Executive Vice President; ARLAND HIRMAN, Treasurer; JOE BILDERBACH, Vice President; JAMES GHERNA, Vice President; GEORGE GLENN, Vice President; THOMAS GRENEY, Vice President; EZRA PINCUS, Vice President; HARRY RAMALEY, Vice President; LOIS SANDERS, Vice President; ABBOTT SPARKS, Vice President. OFFICES: 757 Third Avenue, New York, N.Y. 10017. Phone: (212) 888-4444; 1 East First Street, Duluth, Minnesota 55802. Phone (218) 727-8511. 111 East Wacker Drive, Suite 1730, Chicago, Ill. 60601. Phone (312) 938-2300.



ABOUT THE COVER: The West Texas sun sets behind pumps and pipes of a major enhanced recovery test using carbon dioxide. [Photo courtesy of Standard Oil Co. (Indiana).]

NEXT ISSUE: The second annual Offshore Operations Report will highlight a PETROLEUM ENGINEER International Extra to be published November 15.

Petroleum Engineer® INTERNATIONAL

The international magazine of methods for engineering/operating people

NOVEMBER 1980 NUMBER 13 VOLUME 52

ENHANCED RECOVERY

Sun Gas President Talks About Unconventional And Conventional Gas 20
In an exclusive interview, Robert B. Anderson says his company expects to have more wells being drilled for unconventional gas by the late 1980s than for so-called conventional gas.

New Approach To Secondary Recovery 27
by A. F. van Everdingen and Hyla Swesnik Kriss, DeGolyer and MacNaughton

Response Of An Ellenburger Crude to CO_2 Slugs Pushed By Nitrogen 42
by William A. Aud, Daniel D. Fischer, Raymond A. Haas, Mark S. Gerding, and Paul B. Crawford, Texas A&M University

How To Take Nitrogen Out Of A Gas Stream 50
by J. L. Joplin, Oil & Gas Supply Co., and J. F. Joplin, Oil & Gas Cryogenics

Well Completions And Workovers—Part 11 56
by L. Douglas Patton, H. K. van Poollen and Associates Inc., and W. A. Abbott, Great Eastern Energy and Development Corp.

Computer Output Compares Hydraulic Maximizing Estimates With Laminar Flow Constraints 70
by Alan G. Arbizu and Rodney McGinnis, Milchem Inc.

Downhole Steam Generator Shows Merit 82
Staff Report

Predicting Bottomhole Pressure For Gas And Gas Condensate Wells 90
by Michael Arnondin, Michiel van Poollen, and Fred F. Farshad, University of Southwestern Louisiana

Petroleum Engineering Quiz 124
Great professor is John M. Niedzwecki, Texas A&M University

In-Situ Hydrates—A Potential Gas Source 112
by L. J. Franklin, Panarctic Oils Ltd.

EDITORIAL DEPARTMENTS

News Hi-lites 1
Significant Happenings in Petroleum

Course of Oil 6
Bungling Bureaucrats — the Waste Makers

Technology Trends 8
Forecasts from Current Events

Offshore Technology 10
Buoy Monitors Seismic Activity

Continuous Tables 125

Drilling/Exploration 132
Contrasting Energy Approaches

Industry Meeting Calendar 142

Company News 150

Book Reviews 162

Petroleum Profiles 156
Five minutes with Fred Poettmann

Professional Directory 165

Classified Advertising 166

Index to Advertisers EM 16

ENERGY management report™

by Ernestine Adams

	EM
Comment	1
Energy World Report	2
International Design/ Engineering	4
Offshore Energy Business	6
Financial Notebook	8
New Products	10

NOTE

ONLY THE FOLLOWING PAGES OF THIS

PUBLICATION HAVE BEEN FILMED

Cover 1, p. 4, 63-64.